

conductive film is formed to be in contact with a portion of the first insulating film formed on the side of the trench.

[0016] One form of the semiconductor device disclosed in this specification includes: a substrate; a semiconductor layer provided on a principal surface of the substrate; a trench provided in the semiconductor layer; a gate insulating film provided on a side of the trench, a bottom of the trench, and a periphery of the trench; and a conductive film provided on the gate insulating film to fill the trench and extend on the periphery of the trench, wherein the gate insulating film has a first insulating film provided on the side of the trench and a second insulating film provided on the bottom of the trench and the periphery of the trench, the thickness of portions of the gate insulating film provided on the bottom of the trench and the periphery of the trench is larger than that of a portion of the gate insulating film provided on the side of the trench, a portion of the second insulating film provided on the periphery of the trench has an inclined portion that becomes gradually thicker from the trench-side end, and the inclination angle of the inclined portion with respect to the principal surface of the substrate is 45 ± 5 degrees, and the conductive film is in contact with a portion of the first insulating film formed on the side of the trench.

Advantages of the Invention

[0017] According to an embodiment disclosed in this specification, it is possible to implement a semiconductor device where control of the thickness of the gate insulating film inside the trench and on the periphery of the trench is easy and also embedding of the gate electrode into the trench is facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a graph showing the relationship between the thickness of an insulating film formed on the bottom of a trench and the field strength exerted on the insulating film at the bottom of the trench.

[0019] FIG. 2 is a plan view showing a semiconductor device of an embodiment.

[0020] FIG. 3 is a cross-sectional view showing the semiconductor device of the embodiment.

[0021] FIG. 4 is a cross-sectional view showing a fabrication process for the semiconductor device of the embodiment.

[0022] FIG. 5 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0023] FIG. 6 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0024] FIG. 7 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0025] FIG. 8 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0026] FIG. 9 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0027] FIG. 10 is a cross-sectional view showing the fabrication process for the semiconductor device of the embodiment.

[0028] FIGS. 11(a)-11(c) are cross-sectional views showing a first alteration of the fabrication process for the semiconductor device of the embodiment.

[0029] FIG. 12 is an enlarged cross-sectional view showing a second alteration of the semiconductor device of the embodiment.

[0030] FIG. 13 is an enlarged cross-sectional view showing a third alteration of the semiconductor device of the embodiment.

[0031] FIG. 14 is a cross-sectional view showing a fourth alteration of the fabrication process for the semiconductor device of the embodiment.

[0032] FIG. 15 is a cross-sectional view showing the fourth alteration of the fabrication process for the semiconductor device of the embodiment.

[0033] FIG. 16 is a cross-sectional view showing the fourth alteration of the fabrication process for the semiconductor device of the embodiment.

[0034] FIG. 17 is a cross-sectional view showing a fifth alteration of the semiconductor device of the embodiment.

[0035] FIG. 18 is a cross-sectional view showing a sixth alteration of the semiconductor device of the embodiment.

[0036] FIG. 19 is a cross-sectional view showing a seventh alteration of the semiconductor device of the embodiment.

[0037] FIG. 20 is a cross-sectional view showing an eighth alteration of the semiconductor device of the embodiment.

DESCRIPTION OF EMBODIMENTS

[0038] In the fabrication method for a semiconductor device disclosed in this specification, a gate insulating film is formed by a combination of a high-density plasma chemical vapor deposition (HDP-CVD) method and a thermal oxidation method, for example.

[0039] According to the above fabrication method, it is possible to freely set the thickness of a gate insulating film on the bottom and periphery of a trench and the thickness of a gate insulating film on the side of the trench independently without complicating the process. It is also possible to easily implement a semiconductor device that can prevent or reduce occurrence of dielectric breakdown of the gate insulating film on the bottom of a trench with little influence exerted on properties such as the threshold voltage. Moreover, it is possible to implement a semiconductor device that can achieve both reduction in gate resistance and reduction in gate capacitance and is excellent in high frequency operation.

[0040] First, the required thickness of the gate insulating film will be described. FIG. 1 shows the results, obtained by simulation, of the field strength exerted on the trench bottom in a trench gate structure semiconductor device using 4H-SiC. The drain voltage was set to 1200 V and the junction breakdown voltage between a drift region and a body region to 1200 V or more. The field strength exerted on the trench bottom when the thickness of the gate insulating film on the trench bottom was varied while the thickness thereof in a channel region on the trench side was fixed to 70 nm was obtained.

[0041] As shown in FIG. 1, when the thickness of the gate insulating film on the trench bottom is 70 nm, which is the same as that on the trench side, the field strength exceeds 9 MV/cm. Even when the film thickness on the trench bottom is 140 nm, which is twice as large as that on the trench side, a field strength of 6 MV/cm is exerted on the trench bottom.

[0042] The dielectric breakdown field strength of a normal thermally-oxidized film is 10 mV/cm or more. However, to